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THE DANGERS OF MODERN ANÆSTHESIA DEMAND THE IMPROVED STATUS AND REMUNERATION OF THE ANÆSTHETIST

BY

JOHN ELAM

IT was some little time after Simpson's first use of chloroform that doubts arose in the minds of some observers as to whether chloroform was a drug sufficiently safe for general use. For many years furious arguments continued between those in favour and those against the use of this anæsthetic agent. Yet in all these arguments the real point was missed. It was not the agent in use which was of primary importance, but the anæsthetist in charge of the administration who was really the deciding factor. Until and unless we appreciate this great truth, we shall make little progress in our attempts to reduce anæsthetic mortality and morbidity.

It is not the machine or the drug which should receive our attention, but the user of the machine or the chosen drug. For many years many patients lost their lives because chloroform, a valuable but potentially dangerous agent, was used by imperfectly trained anæsthetists. To-day with the discovery of new drugs we are in grave danger of repeating our past mistakes.

There are modern drugs in daily use which might with good reason be considered far more dangerous than chloroform, and yet because of the ease with which they are

administered their popularity increases. The pleasant induction of anæsthesia with these drugs adds to their popularity.

The barbiturate group of drugs forms a very good example of these "pleasant anæsthetics", yet their safe use does indeed require special skill and experience on the part of the anæsthetist. Unless we have an adequate supply of highly trained anæsthetists the mortality associated with modern anæsthesia is likely to increase.

For some little time the barbiturate group of drugs commonly used for intravenous anæsthesia were thought to be safe, but the ever-increasing mortality and morbidity associated with their administration is giving rise to some concern.

In fact, we may properly say that intravenous anæsthesia occupies a place in modern medicine analagous to the position held by chloroform thirty years ago. Is the history of chloroform to be repeated, and are we to wait many years, and again to lose many hundreds of patients, before a proper understanding is reached as to the place which the intravenous barbiturates shocld occupy in the anæsthetist's armamentarium?

Until such an understanding is reached, untrained practitioners will continue to use drugs which require for their safe use special care and special training. The point at issue is not whether the barbiturates should be used at all but whether, because of their special danger, they should be used by practitioners who have not acquired special experience in the administration of anæsthesia. Also by what means can we obtain a sufficient number of specially trained anæsthetists?

It is not so much a question of how to use these drugs but when to use them, for what type of operation, or what type of patient, and by whom they should be used. It is here that judgment is required. I believe that the dangers of the intravenous anæsthetics have not been appreciated by the general practitioner, who has been gravely misled by the many published accounts of their successful use. These reports have far too often minimised the dangers and over-stressed the advantages to be gained from their administration.

I do not believe that there are many anæsthetists who,

having used intravenous anæsthesia for any number of cases, can say that they have never lost a patient from its use, if they are really honest with themselves.

In support of this submission I would refer to the Editorial in *Current Researches*, September–October 1944, which deals sharply with anæsthetic mortality and tells us that there have been six times as many deaths under Pentothal in the U.S. Army as under any other anæsthetic. In my own immediate district there have been many more deaths due to intravenous anæsthesia than to chloroform anæsthesia, yet chloroform is still used quite extensively. I have had personal experience of losing a patient, and I have experienced one case of very severe laryngeal spasm and one case of delayed recovery, following the use of intravenous anæsthesia, as against no anxiety experienced during twenty years use of chloroform.

I have made a careful search of the literature to see whether I have been unduly lucky or whether there is in the administration of the barbiturates some special inherent danger, to overcome which special skill and judgment are required on the part of the administrator.

In 1941 there were sixty-one deaths associated with the barbiturates reported to the Coroner[1] (*Lancet*, January 15, 1941) and many anæsthetists have reported misadventures. For example, Hoenigsberger[2] (*Lancet*, July 3, 1943), Harris[3] (*Brit. Journ. Anæs.*, April 1937) and Jarman[4] (*Brit. Journ. Anæs.*, April 1939) report fatalities.

Deaths are also reported in *The Archives of Surgery*[5] (August 1944) and in "Current Researches"[6] in *Anæsthesia and Analgesia* (December 1940). *The American Journal of Obstetrics and Gynæcology*[7] (July 1941) quotes Menegaus as reporting twenty-two deaths and Synephias six serious accidents and twenty deaths during short operations under Evipan.

Patterson[8] (*Curr. Res.*, October 1941), Harris[9] (*Lancet*, August 7, 1943) and Woodfield Davis[10] (*Medical Press and Circular*, June 7, 1944) also write of unfortunate occurrences. Thrombosis[11] of a vein (Organe and Brand, *Lancet*, November 19, 1939) and inadvertent injection into an aberrant artery[12] with tragic results have been known to occur (Van der Post, *Curr. Res.*, June 1942; Macintosh and Heyworth, *Lancet*,

November 6, 1943). A. V. Hunter[13] (*Lancet*, January 9, 1943) discusses the dangers of Pentothal Anæsthesia. He describes a case of dermatitis following its use and quotes Gruber, who showed that the injection of a large dose of pentothal is followed at once by a sharp fall in blood-pressure, and says that he has repeatedly observed something of the same kind. He found that pallor, tachycardia and extremely poor radial pulse were by no means uncommon. He calls attention to the dangerous cycle in which pentothal depressing the respiration may cause anoxæmia, which itself further depresses the breathing.

This vicious cycle he considers may be brought on when pentothal is used as the sole anæsthetic for opening the pleura, as the vagal inhibition, which results from collapse of the lung, may give rise to prolonged apnœa. In animals, such apnœas were found to be irreversible. "To use pentothal," he says, "as the sole anæsthetic for intrathoracic procedure is to court disaster."

Mallinson[14] (*Lancet*, December 4, 1943) considered pentothal to be the anæsthetic of choice for most operations, but certain surgeons for whom he worked (*Lancet*, January 15, 1944) could not confirm Mr. Mallinson's happy experience, and said that resuscitation was not infrequently necessary, and that the patients were sometimes knocked out for a day or two after operations which usually gave little anxiety with other methods of anæsthesia.

I have personally noted how patients sometimes appear to be collapsed on the day following an operation performed under continuous pentothal anæsthesia.

I recently had the opportunity of watching an operation for perforated gastric ulcer performed under continuous pentothal. The patient might have been considered a good risk, yet at the end of the operation his pulse was hardly perceptible. He was pale and cold. He never seemed to recover and died forty-eight hours after operation in what appeared to be profound shock.

When pentothal has been used for the induction of anæsthesia, for relatively minor operations, I have seen this followed by delayed recovery and an exhausted state on more than one occasion.

Disasters are becoming more and more frequent as the intravenous barbiturates are more extensively used, and it can no longer be justifiable to describe intravenous anæsthesia as a safe method. In fact, I submit that this is a technique of administration outside the province of the general practitioner.

Knowledge and great judgment are required for its proper use. The general practitioner will avoid much distress and unhappiness by abandoning the use of intravenous anæsthesia for the operations, both major and minor, commonly met with in general practice.

Yet it cannot be maintained that misadventures occur only when the administration is in the hands of the inexpert, as I know of three deaths which occurred when the patients were in the charge of full-time professional anæsthetists, each of whom was on the staff of a major London hospital. All three deaths were associated with multiple dental extractions in elderly patients, an undertaking which could so easily have been performed under gas and oxygen.

It is extremely unfortunate that intravenous anæsthesia is so easy to administer and so pleasant for the patient, otherwise far more attention would have been paid to its very real dangers. There has also been a lamentable reluctance to report unfortunate cases in the medical Press.

It would have been most helpful if all those cases reported to the coroner had been reported in a medical journal as a guide and a warning to other men.

Yet we often read glowing accounts of the successful use of intravenous anæsthesia, and many practitioners have told us of their good results but not of their failures. Twenty-five years ago we read similar reports on the successful results obtained with chloroform, and I have met many men and women who have assured me that they have given many thousands of chloroform anæsthetics without mishap. It is sometimes claimed that intravenous anæsthesia is particularly suitable for war casualties, but the experience of Halford and others at Pearl Harbour did not confirm this suggestion.

Discussing general anæsthesia in shock, Crooke,[15] Morriss and Bowler (*Brit. Med. Journ.*, November 25, 1944, 683-686) found Sodium Pentothal unsatisfactory.

Induction of anæsthesia with pentothal was given to two

burned patients by an expert anæsthetist, yet one almost died on the operating table, and the other caused some anxiety.

Beecher,[16] Carrell, Jane and Evans, (*Ann. Sur.* U.S.A.: 116: 658: 667. November 1942), confirmed the observation of Essex and Seely and Mann, that shock from intestinal manipulation is delayed under intravenous anæsthesia, but they found that there was no significant delay in the onset of shock caused by bleeding when barbiturates were used, as against ether, and considered that barbiturates as compared with ether were not useful in delaying shock. The barbiturates appear to delay shock in comparison with ether only if the chief cause of shock is dehydration or plasma loss from wound surfaces.

They state that the administration of barbiturates to badly wounded may be dangerous, and found that the addition of 100 per cent oxygen as against air did not delay the onset of shock due to bleeding under barbiturates or ether. A. M. Betcher,[17] (*War Med.*, October 1943, U.S.A.), noted some side reaction to administration of pentothal in a military hospital. There was headache occasionally. Nausea and vomiting when occurring, did so several hours late. Laryngospasm occurred after pentothal and scopolamine.

Burnstein[18] and Hershey (*Proc. Exper. Biol. and Med.* 53: 80–81, U.S.A., May 1943), carried out experiments on animals and found that a considerable number of these animals died after readministration given when the previous dose had worn off.

The investigation was prompted by the death of a patient under pentothal given after acute inadequately treated haemorrhage.

In deaths occurring in animals, autopsies showed markedly dilated heart. The authors considered that following haemorrhage the circulatory effects of pentothal are unpredictable.

In 14 out of 19 experiments in animals they were found to be rapidly deleterious. These investigators say that "The impression that pentothal is safe or beneficial in shocked cases is not established and should be tempered."

*Charles Adams[19] in *Intravenous Anæsthesia* gives an

* "Intravenous anæsthesia," by R. C. Adams. (Paul B. Hoeber Inc., New York and London.)

admirable survey of the physiology of Pentothal Sodium. He found that this drug is a respiratory depressant, and that the degree of depression is directly proportional to the size of the dose administered and the rapidity of intravenous injection.

Complete respiratory arrest may occur but usually the heart keeps on beating for a few minutes after the respirations have ceased, unless attempts at artificial respiration are delayed more than one to two minutes, or if marked cyanosis is present, or if the action of the heart has become feeble.

From their experimental work on dogs, cats and rabbits, Mousel and Essex[29] (*Anæsthesiology*, May 1941, 272–280) were of the opinion that so-called analeptics and respiratory stimulants such as coramine or picrotoxin, were of doubtful value in the treatment of severe respiratory depression caused by pentothal sodium anæsthesia. Charles Adams (Intravenous Anaesthesia), believes that although acute respiratory depression has usually been attributed either to overdosage or to some particular pathologic condition on the part of the patient, yet the explanation of such depression and failure under barbiturate anæsthesia may not be quite so obvious. He holds that certain conditions may increase the toxicity of the barbiturates. (1) Overdosage alone. (2) When the oxygen content of the blood may be low. (3) Response to the barbiturates when the oxygen content of the blood is high. (4) Respiratory alteration and failure following administration of the drugs when the carbon dioxide content of the blood is high. (5) Respiratory failure under a combination of (2) and (4). (6) Condition of positive pressure in the airway and the breathing of 100 per cent oxygen. On the basis of experimental studies, Beecher and Moyer expressed the opinion that the use of barbiturates is contra-indicated in conditions in which the concentration of oxygen in the blood may be low or the concentration of carbon dioxide high.

It has also been shown that respiratory depression and failure can result in the presence of a small elevation of pressure in the airway plus the administration of 100 per cent oxygen.

Adams considers that there are real dangers in attempting to stimulate a depressed or arrested respiration as a result of barbiturate anæsthesia, by the addition of synthetic carbon

dioxide when the respiratory centre has already been depressed or paralyzed by the accumulation of carbon dioxide and by a barbiturate.

The barbiturate group of drugs appear to affect the heart and there is marked decrease in the force of the contractions of auricles and ventricles with a simultaneous dilatation or increase in the volume of the heart following administration. This results in a weakening of the force of the contractions.[21] (Gruber, Pentothal, *Journ. Phar. and Exper. Therapy*, 60: 143–172, June 1937.) Cardiac difficulties are greatly increased if respiratory embarrassment becomes acute.

On the basis of the results of their experiments on cats and dogs, Reynolds and Veal and Chapman[22] (*Proc. Soc. Exper. Biol. and Med.*, 37: 627–628, January 1938), expressed the opinion that the continuous administration of pentothal sodium in doses sufficient to maintain only light anæsthesia, brings about signs of poisoning of cardiac muscle.

The longer the administration lasts the greater is the danger to the circulatory mechanism.

Gruber[21] expressed the opinion that the fall in blood-pressure is due mainly to cardiac injury and dilatation of the arteries, capillaries, and venules of all the organs of the body. Adams (*Intravenous Anæsthesia*), discusses pathologic changes in various organs of the body and says that Grunzit, Dox, Rowe and Dodd examined animals that died following administration of large doses of thiobarbiturates. They found extensive pathologic changes in the lungs, liver, kidneys, and other organs. Microscopic examination showed these changes to be alike, regardless of the thiobarbiturate administered. Adams also reports a truly alarming number of misadventures under Evipan and Pentothal Anæsthesia.

From a study of the literature available then, we must conclude that while intravenous anæsthesia is undoubtedly pleasant for the patient and is easy of administration, yet it does carry with it undoubted hazards of very great magnitude.

I do not believe that the inventors or sponsors of these drugs ever intended that they should be used in the spirit of light-hearted abandon, so often met with to-day, but rather that their use should be confined to the practice of the specialist in anæsthesia.

To the credit of the makers of pentothal, it must be admitted that they advise extreme caution and that the drug shall be used only by experienced anæsthetists. This advice has not been followed.

It is becoming daily more clear that if these new agents, which are more comfortable but far more dangerous than chloroform, are going to be used, they must be used *only* by well-trained experts, if tragedies are to be avoided. But where are the experts?

Anæsthesia is not a popular branch of medicine because the responsibility of the anæsthetist is great, the work hard and, even in London, the reward ridiculous.

People will not pay for a good anæsthetic, given by the professional, as I well know after twenty-one years in general practice. So young people on completing their medical education have no encouragement whatsoever to take up the art and science of anæsthesia as a speciality. For my own part, with things as they are, I would be the last person to advise our young people to become full-time anæsthetists.

The public will get exactly what they pay for. Their troubles are of their own seeking.

If the people of this country really want to obtain full advantage from new therapeutic discoveries, they must be prepared to ensure that the reward of the expert anæsthetist shall correspond with the work he or she has to do.

It would be greatly in the public interest if there were a sufficient number of specially trained anæsthetists who could make themselves responsible for the administration of such anæsthetic agents as required for their proper use, special skill and experience.

Summary.

Modern anæsthesia has become a dangerous branch of therapeutics, and modern drugs are more dangerous than chloroform which was condemned for its danger many years ago. As an example of the special dangers associated with "modern anæsthesia" the hazards of intravenous anæsthesia have been considered.

While the use of the barbiturate group of drugs holds many advantages for the patient, yet the comfort of the patient and the ease of administration must not be the only consideration. Intravenous anæsthesia requires for its successful practice specially trained and experienced anæsthetists, a sufficient number of whom are not available.

Unless the public are prepared to improve the status and reward of the anaesthetist, these specially trained experts will not become available and many lives will be lost as a result of foolish attempts to obtain "medicine on the cheap."

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POST-OPERATIVE PULMONARY ATELECTASIS

BY

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COLLAPSE of the lung was first suggested by Gardiner in 1850, but was not recognized as a post-operative complication until about sixty years later, when William Pasteur noted it as a definite clinical entity. He first recognized a condition of pulmonary collapse in patients suffering from post- diphtheritic diaphragmatic paralysis, and attributed it to deficient expansion of the basal lung areas consequent upon inadequate respiratory excursion. In 1925 Lee and Jackson demonstrated bronchoscopically complete bronchial obstruction due to a tenacious plug of thick mucus.

Atelectasis is probably the commonest pulmonary complication of abdominal operations. It is generally agreed that the two major precipitating causes are limited respiratory movements and bronchial obstruction with a mucus plug. The factors involved in the production of the former are the use of tight binders restricting lower chest movement, Fowler's position, and the natural reluctance of the patient to take a deep breath which would result in pain from the abdominal wound. In addition, the use of morphia pre- and post-operatively results in depression of the respiratory centre and diminished pulmonary ventilation. Bronchial obstruction is also the resultant of several factors: the cough reflex, which normally prevents accumulation of secretions in the bronchial tree, is depressed by pre-operative morphia, abolished during inhalation anæsthesia, and again depressed after operation. During anæsthesia secretions accumulate and cannot be expelled, which results in diminution of the ciliary movement which should sweep them towards the main bronchi. These secretions, normally thin and watery, are dried up into stiff

plugs by the use of atropin as a premedication. After operation the patient is loth to make the coughing effort necessary to expectorate these viscid plugs because of the pain entailed. James Marshall[1] maintains that as soon as a mucus plug begins to obstruct a bronchus the latter goes into spasm, thus increasing the obstruction. Hara[2] postulates in addition a vasomotor reflex via the vagus which promotes pulmonary stasis. Important contributary causes are any conditions which are characterized by excessive bronchial secretion and deficient bronchial drainage, such as bronchiectasis and chronic bronchitis.

It was at one time fashionable to lay most of the blame at the door of the general anæsthetic—usually ether—but, as Geoffrey Marshall and Foster Carter[3] point out, the analysis of cases carried out by D. S. King at the Massachusetts General Hospital in 1933, reveals the highest incidence of atelectasis in cases receiving local anæsthesia. The explanation of this lies probably in the fact that in these cases premedication is often pushed to the stage of basal narcosis, entailing larger doses of morphia and atropin derivatives. The same authors quote the experiments of Band and Hall in 1932, who introduced a sterile gum solution of a viscosity similar to that of the sputum in cases of post-operative collapse into the bronchi of animals in whom the cough reflex had been impaired and either the diaphragm paralysed or a tight binder placed round the lower chest. Collapse of the lung occurred in all cases.

All authorities maintain that the highest incidence of atelectasis occurs after upper abdominal operations. D. S. King[4] found that in a group comprising all laparotomies and hernia operations the incidence was 14 per cent, and in operations on the stomach, duodenum, and gall bladder, it was 35 to 46 per cent. In laparotomies and hernias under general anæsthesia, the rate of pulmonary complications was 12 per cent, under spinal anæsthesia 16 per cent, and under local anæsthesia 18 per cent. Collapse may, of course, occur after any operation, but in King's series the incidence was only 6 per cent for all operations. The figures above actually refer to all pulmonary complications, but as will be seen later, it is the purpose of this paper to suggest that the vast majority, if not all,

post-operative chest complications (excluding pulmonary embolism) are due primarily to atelectasis. Henry[5] considers that collapse occurs in 10 per cent of all abdominal operations and in 30 per cent of all operations in the epigastric region. Hara[2] rates the incidence of atelectasis at 2 per cent to 4 per cent for all operations, and is of the opinion that collapse accounts for 60 per cent to 70 per cent of all post-operative lung complications. He notes that after upper abdominal operations there is a 65 per cent to 70 per cent reduction of vital capacity, while after lower abdominal operations the reduction is 45 per cent to 50 per cent, and after haemorroidectomies, only 8 per cent. Henry[5] states that atelectasis occurs twice as commonly in men as in women, probably owing to the fact that men use diaphragmatic respiration more than they use the intercostal muscles, and women vice versa.

There are several types of post-operative collapse. The classification of Schotz[6] is based on the distribution of atelectasic areas in the broncho-pulmonary segments: thus he describes two forms. Firstly, the well-recognized massive collapse of a lobe or lobes, and sometimes of one complete lung, produced by blockage of the bronchus supplying the lobe, or of the right or left main bronchus. Subsequent to the blockage the air in the pulmonary segment supplied is rapidly absorbed into the bloodstream and the lung collapses, resulting in the typical clinical and radiological picture of massive collapse. The second type is due to the simultaneous obstruction of a large number of scattered bronchioles, probably through the breaking-up of a larger mucus plug temporarily halted at a proximal bronchial division, and aspirated further instead of being expectorated. This type gives none of the typical signs of atelectasis, since there is no mediastinal shift, typical X-ray shadow or diaphragmatic elevation, and the condition cannot be differentiated from a patchy bronchopneumonia, which, indeed, it rapidly becomes. Hara[2] recognizes the existence of a third type of atelectasis, which he terms anæesthetic collapse, occurring during, or immediately after, operation, particularly when performed under cyclopropane anæsthesia. This type is characterized by its extreme rapidity and the absence of any bronchial obstruction. Jones and Burford[10] in a report on four cases, termed the condition

"creeping atelectasis," and regarded it as a result of high concentration of oxygen and deficiency of nitrogen in the inhaled air during the administration of cyclopropane. Long continued shallow respirations result in marked hypoventilation in certain portions of the lungs, so that patches of atelectasis result. Scholtz[4] reports a case of acute massive collapse under cyclopropane anæsthesia in a woman undergoing vaginal hysterectomy. There were no abnormal features except considerable obesity, and anæsthesia was proceeding normally until about fifteen minutes after the induction, when the patient suddenly became extremely blue, and stopped breathing. All attempts at resuscitation were in vain, and post-mortem revealed total collapse of both lungs except for a small portion of the right middle lobe. There was no evidence of bronchial obstruction. Histologically the lungs showed a combination of atelectasis, oedema, and haemorrhages into the alveoli. Scholtz does not agree with Jones and Burford's theory of the aetiology, but maintains that there is a neurogenic mechanism involved, and that the lung is a muscular organ capable of undergoing active contraction. This hypothesis has been advanced by other workers, who maintain that it is a vagal reflex.

Hara[2] has also described four types which may be recognized bronchoscopically:

1. *Allergic Type*: In these cases there is an outpouring of thin watery secretion from the bronchial tree, with intense mucosal injection. As much as 200 c.cm. may be obtained by aspiration, and the patient threatens to drown in his own secretions.

2. *Exudative Type*: Most cases of post-operative atelectasis belong to this group. Thick, viscid, tenacious, greyish-yellow odourless mucus is found in the lower air passages, usually amounting to about 5 to 7 c.cm., but occasionally exceeding 10 c.cm. The bronchial mucosa varies in colour from a bright pink to a faint salmon colour. In atelectasis of the lower lobe the secretion extends above the middle and upper lobe bronchial orifices, and may even spill over into the opposite lung. Hence the danger of progressive atelectasis unless the bronchi are efficiently drained.

3. No plug of mucus is found blocking the collapsed lobe's

bronchus, but some exudate is found in the main bronchi and trachea. Presumably the mucus plug has been coughed up during the preparations for bronchoscopy. The bronchial mucous membrane is intensely congested, and pungent fumes emanate through the bronchoscope.

4. A very small group in which no characteristic finding is observed.

The signs and symptoms of massive collapse are well known. Usually 12 to 48 hours after operation, but occasionally after a longer period, the patient develops a dry cough, accompanied by a rise in temperature, respiration and pulse-rates; there may be pain of pleuritic type over one side of the chest. After a time a little viscid sputum is expectorated with difficulty; it is usually not bloodstained. If the collapse is considerable, then pronounced respiratory distress accompanied by cyanosis occurs. Examination of the chest reveals deviation of the trachea to the affected side, poor movement over the area of collapse, impaired percussion note, diminished voice sounds, and absent or distant tubular breath sounds, with showers of moist *râles*. In a few cases there may be increased tubular breath sounds accompanied by bronchophony—signs of consolidation. This variation is due to the presence of a fairly large patent bronchial tube close beneath the chest wall. Too much reliance should not be placed upon tracheal deviation in cases of collapse of part of a lobe, since minor degrees of shift are not easy to detect with certainty, and the presence of pleural adhesions on the contralateral side anchoring the mediastinum cannot always be excluded. Displacement of the cardiac apex is often a more reliable sign in persons with a thin chest wall. Nevertheless, as long as the possibility of collapse is borne in mind, it should be possible to make a reasonably confident diagnosis on clinical grounds alone.

As would be expected, there is commonly a polymorphonuclear leucocytosis, and the X-ray signs of collapse of the lower lobe are characteristic: a homogeneous ground-glass opacity occupying the cardiophrenic angle and having a well-defined concave or straight margin. The heart and mediastinum are displaced to the affected side, the diaphragm is elevated, the rib spaces overlying the collapsed lobe narrowed. In cases of some standing compensatory emphysema may be seen in the

uncollapsed areas of the same lung. When, however, there are large areas of patchy collapse involving parts of more than one lobe, the characteristic shadow will be absent, the opacities being suggestive of a patchy pneumonia, and only the mediastinal shift and diaphragmatic elevation will point to the correct state of affairs.

The clinical and radiological signs of patchy collapse due to scattered bronchiolar obstruction, as quoted by Schotz[4] are in no way typical. The onset is usually more insidious, the temperature, pulse- and respiration-rates being less elevated, and pleuritic pain commonly being absent. Examination reveals no abnormality whatever, save scattered rhonci and moist *râles*, and there is no mediastinal shift. Radiologically there are only a few scattered fluffy opacities, suggestive of bronchopneumonia, and no mediastinal shift or diaphragmatic elevation. It is this type of case which is invariably regarded as a mild broncho-pneumonia (which indeed pathologically and clinically it closely resembles), post-operative bronchitis, or merely dismissed with the term 'post-operative chest.'

The complications are not numerous but very important. Atelectasis is always accompanied by some infection in the lobe involved, which may progress to frank pneumonia or lung abscess during the first days or weeks, and to bronchiectasis later. As has already been mentioned, there is always a tendency for the collapse to spread, and in cases of sudden extensive massive collapse the patient's life may be in danger.

The prevention of post-operative atelectasis has been the subject of many writings by anæsthetists, physicians, and surgeons, but agreement on general principles has been reached. Morphia may be given pre-operatively, but should be given only in small dosage post-operatively unless there is some very urgent indication for the exhibition of large doses. If possible atropine should not be given as a premedication, and should never be given in the post-operative period because the patient appears to be 'bubbly'. After operation the patient should be encouraged to carry out simple breathing exercises designed to aerate the lung bases as fully as possible several times daily. Expectoration should be encouraged by the use of a simple potassium iodide mixture.

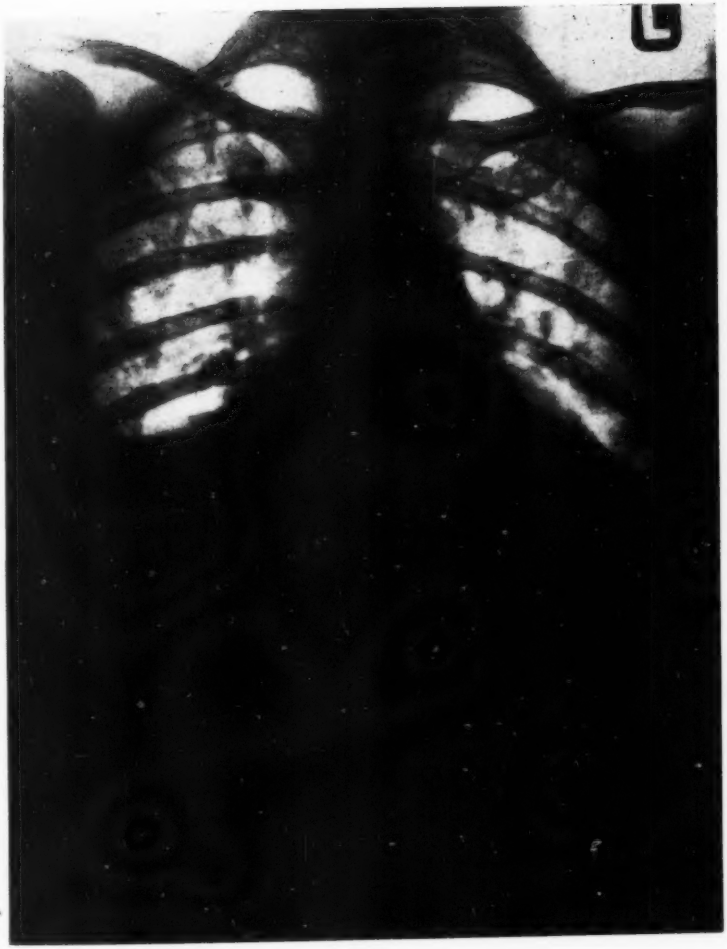

FIG. 1.

J F G.

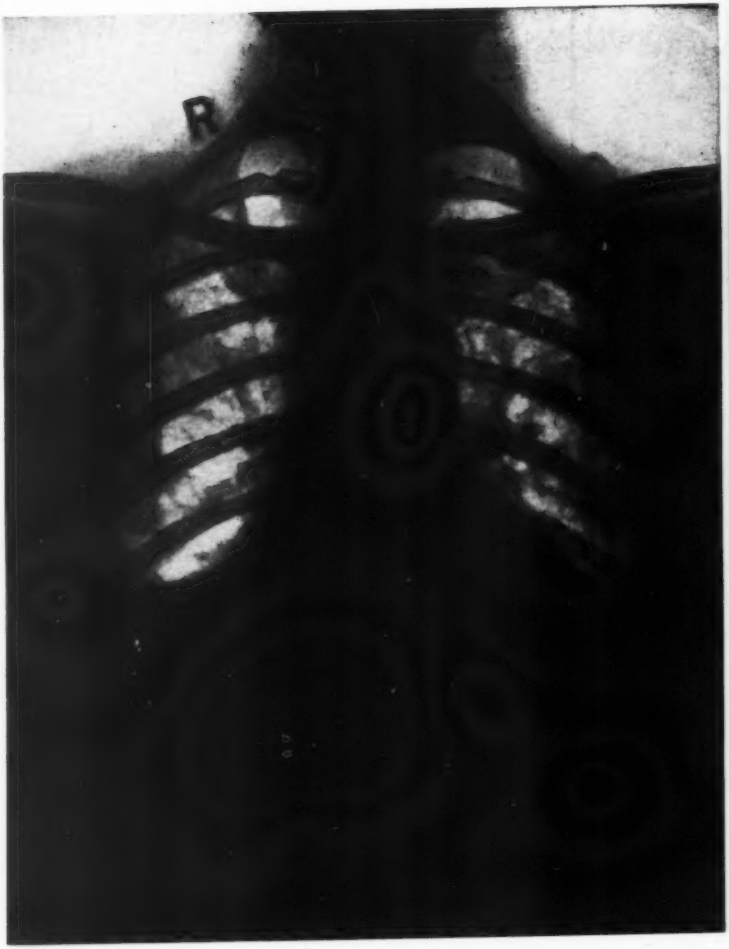

FIG. 2.

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FIG. 3.

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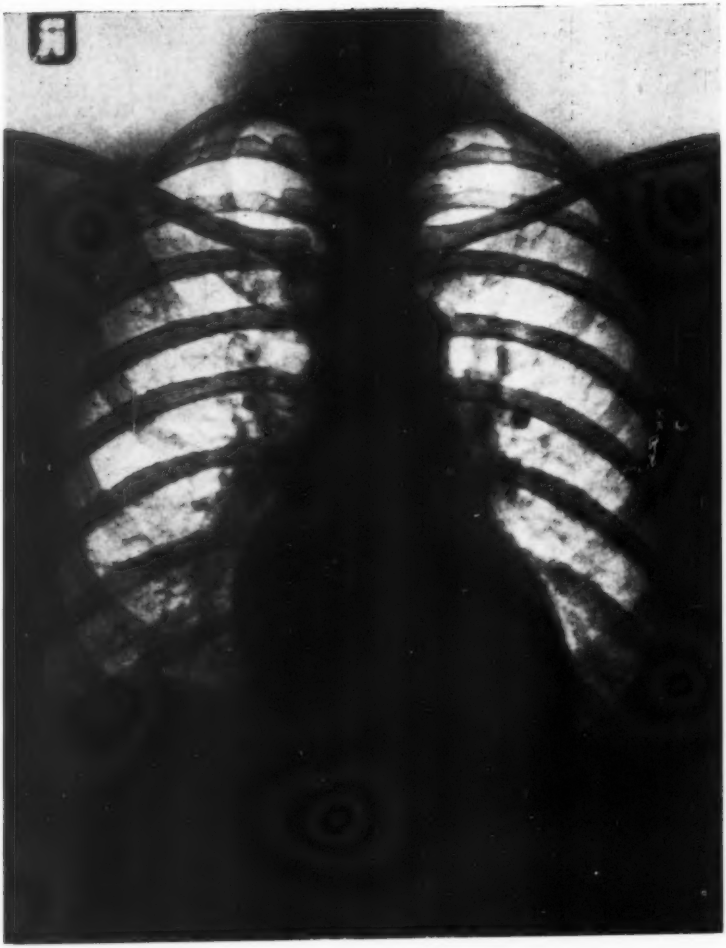

FIG. 4.

J.F.G.

The lower part of the chest should never be constricted by a tight binder, and wherever possible an elastoplast corset should be substituted for an abdominal binder. James Marshall[1] advises that the patient's position should be changed several times daily, but this is not always possible during the critical period. He also advises the inhalation of 5 per cent CO_2 and 95 per cent oxygen at intervals during the day to encourage hyperventilation, though this is open to the objection that plugs of mucus may be sucked further into the bronchial tree. In addition, he recommends similar inhalations during the course of spinal anæsthesia. Inhalations of pure oxygen are not infrequently given during spinal anæsthesia to relieve faintness, but it seems possible that the addition of CO_2 would disturb the patient by its hyperventilation effects.

Henry[5], J. Marshall[1], and Schmidt, Mousel and Harrington[7] all agree that elective operations should be performed when upper respiratory infections and oral sepsis are absent, and Marshall insists that the bronchial secretions should be minimal. The last-named authors maintain that prolonged anæsthesia should be avoided, but Hara[2] does not consider this a factor of importance. Patients with severe chronic bronchitis and bronchiectasis should be bronchoscoped immediately after operation (Schmidt, Mousel and Harrington).

Treatment of the established condition consists in efforts to remove the obstructing mucus plug, and to increase pulmonary ventilation. Measures designed to liquefy secretion and stimulate coughing should be instituted at once. A potassium iodide expectorant mixture should be administered every two or three hours, and Hara[2] suggests inhalations of friar's balsam. All tight binders should be removed and the patient urged to cough as much as possible. In addition, the patient should be 'tipped' at least twice daily into the position from which gravity will assist drainage from the affected lobe. Percussion on the chest wall ('tapping') over the collapsed lobe in order to dislodge the sticky plugs is also of value. Deep-breathing exercises are usually agreed to be useful, but the practice of giving frequent inhalations of 5 per cent CO_2 to promote hyperventilation is not universally approved. Those who do not advocate its use maintain that it tends merely to drive the mucus plugs further into the bronchial

tree—possibly converting a localized lobal collapse into a diffuse lobular one. Thus G. Marshall and Foster Carter[3] are of the opinion that: " . . . Inhalations of carbon dioxide are of no value and the resulting hyperpnœa may aspirate the secretion further down the bronchi . . ." However, J. Marshall[1], Schmidt, Mousel and Harrington[7], and Henry[5] are all convinced that the resultant hyperpnœa promotes bronchial drainage and expectoration of mucus rather than the opposite. The writer of this paper is in agreement with their views, being of the opinion that, provided the other measures outlined above have been carried out, carbon dioxide inhalation is of value. Maurice Davidson[8] is doubtful of the wisdom of carbon dioxide inhalation, but does not condemn it. G. Marshall and Foster Carter[3] consider the most useful treatment to be the employment of Santé's manœuvre, but they emphasize that it must be carried out without delay. The manœuvre consists of placing the patient on his back and rolling him gently a dozen times, first on one side and then on the other. If this does not cause the plug to be dislodged and expectorated the procedure should be repeated four-hourly until the mucus is expelled. Heavy percussion over the affected area is considered as a useful anciliary measure.

Bronchoscopy and Bronchial Catheterization.

Nearly all physicians are agreed that removal of the obstructing plug of mucus by endoscopic means has a place in the treatment of post-operative atelectasis, but there appears to be little agreement at the present as to the optimum time at which to perform the operation, or how frequently the measure should be employed at all; since without doubt a large proportion of cases recover without any such interference. Henry[5] considers that bronchoscopic aspiration is of value in all cases, especially in the early stages before the onset of complications, and stresses that it should not be regarded as a terrible ordeal from which the patient should be protected until all other measures have failed. He considers that where bronchoscopy is not available bronchial catheterization under local anæsthesia has much to recommend it. He advises that bronchoscopy be performed under local anæsthesia by cocainization of the throat and larynx after pre-

medication with nembutal, but has had good results using pentothal anæsthesia : he does not mention an optimum time for bronchoscopy, but implies that it should be done as soon after the collapse has occurred as possible, and emphasizes that early bronchoscopy diminishes the chance of infection in the collapsed lobe. Hara[2] is of a similar opinion, and notes that if it is carried out within twenty-four hours the temperature usually returns to normal within twelve to twenty-four hours. Schotz[6] says that immediate bronchoscopy is the most efficient single measure. Schmidt *et al*[7] maintain that most cases can be cured by deep-breathing exercises and hyperventilation with CO_2 and oxygen, but advise bronchoscopy if prompt relief does not ensue. G. Marshall and Foster Carter[3] do not consider bronchoscopy as effective as Santé's manœuvre. Davidson[8] states that if bronchoscopy is to be performed it must be done within twelve hours. He also mentions the induction of artificial pneumothorax on the affected side to diminish the mediastinal shift due to the high negative intrapleural pressure, which pressure might conceivably tend to drive the plugs further into the bronchi. Coope[9] also mentions the induction of a pneumothorax, and considers that bronchoscopy is not always successful, but may be tried if simple measures have achieved no results within forty-eight hours : he notes that the mucus may be so tenacious as to require removal with forceps.

The use of sulphonamides appears rational and necessary, and all patients should receive a full course as soon as the condition is diagnosed, since in cases where infection has not yet occurred the sulpha drugs act as an important means of prophylaxis. The drug of choice is sulphamezathine, and 6 g. daily should be given over a period of from five to eight days.

Cyanosis or moderate respiratory distress should be the indication for oxygen therapy, preferably through a B.L.B. mask.

The prognosis in the majority of cases is good, and the collapsed lobe usually expands fully within one or two weeks of efficient treatment being instituted. As has been mentioned, most cases recover without bronchoscopy, if not rapidly, within the course of several weeks. However, while the lung remains wholly or partially collapsed the patient is running

a risk of immediate pneumonia, late lung abscess, and remote bronchiectasis. In addition, undesirable emphysema is being developed compensatorily in the other parts of the lung. On these grounds alone it seems reasonable to advise bronchoscopy on all cases in whom either conservative treatment or immediate bronchoscopy have failed to produce results within seven to ten days. It is probable that the most important factor in the production of bronchiectasis is obstruction of bronchioles, with patchy partial collapse, and ball-valve action of the obstruction, so that air can enter the infundibula, but cannot get out except by rupture of the air sacs. The increased intrapleural negative pressure exerts a pull on the atelectatic lobe which is transmitted irregularly to the bronchioles, leading to dilatation. Infection of the stagnant secretions soon weakens the bronchiolar walls still further until an irreversible change has taken place. It seems probable that when a plug of mucus blocks a bronchus and the lobe collapses, the increased negative intrapleural pressure, as Davidson suggests, drives portions of the plug, which have been broken off the main mass, further into the bronchial tree, giving rise to just that partial bronchiolar obstruction which tends to produce bronchiectasis. It does not seem unreasonable to suggest that many cases of basal bronchiectasis for which no cause is found are due primarily to unrecognized partial lobar atelectasis following abdominal or other operations.

Particularly liable to be missed is the scattered bronchiolar type of collapse, which will never be diagnosed correctly unless the likelihood of the condition occurring is borne in mind. It might be argued that since this state is so similar pathologically to simple broncho-pneumonia, then treatment along lines similar to those suitable to that condition should suffice, and that logically if bronchoscopy is to be applied to this type of collapse it should also be applied to primary broncho-pneumonias. This argument can be seen to be invalid when it is realized that in post-operative collapse there are several additional disadvantages to be overcome for the patient which are not present in simple broncho-pneumonia: poor cough reflex, tenacious mucus, limited respiratory movements.

The majority of post-operative pulmonary complications

are, excluding pulmonary embolism, in all probability the direct result of some form of pulmonary collapse, and if this fact is recognized and the simple physical manœuvres designed to dislodge the mucus plugs carried out the results will fully justify the time spent on their execution, and it is possible that the incidence of 'idiopathic' basal bronchiectasis may be lowered.

There is no doubt that while the optimum time for bronchoscopy is within the first twenty-four hours after collapse has occurred the procedure can be employed with benefit up to fourteen days after, and possibly longer. In fact, should simple measures fail to achieve any results within five to seven days, bronchoscopy should not be neglected.

Report of a Case Treated by Bronchoscopy

A single woman, aged 39, was operated on for the removal of a right hydrosalpinx and left pyosalpinx and ovary on January 3rd, 1945. General anæsthesia by nitrous oxide, oxygen and ether was employed, and premedication was with omnopon g. $\frac{1}{3}$ and scopolamine g. $\frac{1}{150}$. On the day following the operation she developed a dry cough, and on January 5th, 1945, she developed a sharp pain in the left chest, the cough became harsh and painful, and the temperature rose to 101°F. I first saw her on January 10th, 1945, when the temperature had fallen to 99°F., but the respirations were 32/min., and pulse 100/min. There was no cyanosis, labial herpes, or finger clubbing, but the tongue was furred. Examination of the chest revealed possible slight tracheal deviation to the right, but no displacement of the cardiac apex. There were no abnormal signs in the lungs except over the right lower lobe, which revealed impaired percussion note, with an area over the region of the middle third of increased tubular breathing, bronchophony and sticky crepitations. Inferior to this, at the base, there was almost complete dullness to percussion, almost absent breath sounds, and diminished voice sounds with a few crepitations. A diagnosis of pneumonia with effusion, or post-operative collapse of the right lower lobe was made. Portable X-ray of the chest showed pneumoperitoneum

and partial collapse of the right lower lobe, with minimal lamellar pleural reaction (Fig. 1). Blood Count: Hb. 70 per cent. WBC. 10,000/c.mm. Polymorphs 68 per cent. Sputum: mixed flora, mostly Strep. viridans. No tubercle bacilli.

It was felt that since the optimum time for bronchoscopy had passed conservative measures should be employed. The patient was given Sulphamezathine 2 g. statim, and 1 g. four-hourly for six days, inhalations of 5 per cent CO_2 for five minutes every hour, and a potassium iodide mixture four times daily. Postural drainage, breathing exercises, and percussion over the affected area were commenced, and she was instructed to cough as much as possible. The abdominal binder was loosened, and an elastoplast dressing substituted. Her clinical condition rapidly improved, and within twenty-four hours she was quite comfortable, though complaining of some pain from the abdominal wound on coughing, and the temperature, pulse and respirations were normal. The clinical signs of consolidation disappeared but those of collapse remained. A further X-ray on January 12th, 1945, showed little if any change (Fig. 2). Bronchoscopy was decided upon, and was very kindly performed the next day by Mr. J. F. Simpson, under pentothal anæsthesia. No mucus plug was seen, and there was little, if any, excess of mucus in the bronchi. The patient coughed violently during the preparations for the operation. X-ray after bronchoscopy showed partial expansion of the right lower lobe, and a small area of atelectasis or consolidation in the left lower zone, which had not been present before (Fig. 3). The patient was by now asymptomatic as regards her chest, and the clinical signs were appreciably less—there was no rise in temperature. On January 23rd, 1945, the clinical signs had all resolved, and X-ray on the following day showed that both bases were quite clear (Fig. 4).

It seems probable that this case corresponded with Schotz's, type 3, and the plug had been expelled during the coughing induced by the preparations for bronchoscopy. It is worthy of note that the disappearance of the pneumoperitoneum coincided with the re-expansion of the right lower lobe, which raises the question that the right subdiaphragmatic air bubble might be a possible factor in the ætiology of the collapse.

ACKNOWLEDGMENTS

I should like to express my sincere thanks to Dr. H. Courtney Gage for permission to publish the X-ray films, for their reproduction, and for much helpful advice and criticism. I am also indebted to Mr. Douglas MacLeod for permission to publish details of his case, and to Mr. J. F. Simpson for kindly performing the bronchoscopy.

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EPIDURAL ANALGESIA FOR CÆSAREAN SECTION

BY

D. M. E. CROUCH, M.B., AND EDITH S. M. MERRY, M.B.

THE choice of anæsthesia for Cæsarean section is of major importance and has always been a difficult problem. First, it must be safe for mother and child and, secondly, provide operative comfort for the surgeon. We have been conscious of this at U.C.H., where the lower segment operation is almost always done, when general anæsthesia is contra-indicated as in diabetes, toxæmias of pregnancy, kidney or cardiac disease, placenta prævia and when uterine inertia has been present during labour; in tuberculosis, upper respiratory infections, asthma and chronic bronchitis. The dangers of uterine atony, post-partum hæmorrhage, aspiration pneumonia, paralytic ileus, fœtal asphyxia, especially where prematurity and fœtal distress exist, following general anæsthesia for Cæsarean section are constantly in the mind of the anæsthetist.

Local Analgesia by abdominal field block for such cases has not been altogether effective in relieving pain, particularly when the peritoneum is under tension, as when the Doyen retractor is used for exposure of the lower segment. Further, relaxation of the abdominal wall is not necessarily adequate to allow painless packing off of the peritoneal cavity, and the effect of painful traction on the viscera in producing shock is well known.

Spinal Analgesia has not been tried at U.C.H. in view of the somewhat unfavourable literature with reports of collapse due to falls in blood-pressure, severe headaches, meningitis, paralyses and sudden death due probably to faulty technique.

Many of you will recall Dr. Massey Dawkin's paper on Epidural analgesia, given before the Royal Society of Medicine in January. Having watched his work and tried his

method it occurred to us that its application to Cæsarean section would prove of value in certain cases. We have carried out a very modest series and do not advocate that it is necessarily the anæsthetic of choice for all cases, but it does seem to be an answer for the type of case described where general anæsthesia is contra-indicated. Actually we have used it for almost all Cæsarean sections at U.C.H. recently just to gain as much experience of the method as possible, and it is hoped that this preliminary investigation will encourage others to try it and widen the scope of our knowledge and experience.

Premedication has been two doses of 100 mg.: of Pethedine, one 1½ hours before and the second ¾ hour before operation, given intramuscularly. We have found Pethedine of great value in all cases for allaying mental anxiety, and we have noticed no adverse effect on the infant, nor more than a tachycardia in the mother. However, if fœtal distress were present it would be wiser to forego the pethedine.

We have always explained the procedure simply to the mother, making clear to her the difference between touch and pain.

Pre-operative use of pressor drugs has been omitted in patients with a blood-pressure of 150 mm.: Hg: and over and has not been given routinely unless the blood-pressure has shown a tendency to fall.

Technique

Briefly, here is the technique employed. The patient lies on her side with the spine flexed. In spite of the enlargement of the abdomen at term, most patients have been co-operative and arched their backs quite well. The skin is thoroughly cleansed with triple dye and an intradermal wheal of 1 per cent Novocaine raised between L_2 and L_3, because the epidural space is wide at this level and the cord is not likely to be damaged. The Howard Jones spinal needle is inserted in the mid-line. Odom's glass indicator containing an air bubble is attached and then the needle is very slowly advanced through the ligamentum flavum until the resistance suddenly gives and the air bubble is sucked in towards the patient by the negative pressure in the epidural space. If no negative pressure is observed, another space may be tried.

We use 1 in 600 Nupercaine in 0.45 Normal Saline, 45 c.cm. in all, 10 c.cm. of which is injected slowly, aspirating several times during its introduction, to make sure that C.S.F. is not being withdrawn. A wait of 5 minutes is now made in order to make sure again that the subarachnoid space has not been entered. If it has, C.S.F., which is warm, will drip out and a low spinal block will have occurred and voluntary movement of the toes will be impossible. Voluntary movements are not affected by epidural technique.

Following this safety pause, a further 35 c.cm. of Nupercaine are injected slowly, always aspirating several times and asking the patient to move her toes. This is well within the maximum dose and we have seen no toxic effects. The needle is then removed and the site of puncture covered with elastoplast, and the patient lies on her back at a slight foot-down tilt while the analgesic solution is acting. This usually takes 20 minutes and the surgeon should be discouraged from starting until analgesia is complete, otherwise the confidence of the patient is lost. With this dosage analgesia reaches approximately D8 to D10. The level of analgesia can also be controlled by the position of the patient and we aim at analgesia to the umbilicus. A slight head-down tilt will produce the desired height in those cases where analgesia has not reached the umbilicus within 10 to 15 minutes after injection.

It is important to ensure that the patient is comfortable and those with the right temperament are engaged in conversation and others left to sleep. Those who definitely asked to go to sleep were given a light gas and oxygen supplementary anæsthesia or analgesia.

Blood-pressure records were kept without much disturbance to the patient as they were fully acquainted with the sphygmomanometer and cuff during pregnancy. Several patients required no ephedrine at all and others who did responded to it very readily.

Relaxation of the abdomen muscles was good, intraperitoneal packs were inserted without discomfort, exposure of the lower segment was painless and the abdomen was quiet.

The babies have breathed spontaneously on delivery and no change in the fœtal heart-rate has been observed following the injection. The two smallest, delivered at 34 weeks,

weighed about 3 and 3½ lb. respectively. Those mothers who remained awake during the procedure were delighted and encouraged by seeing their babies immediately after they were born.

Retraction of the uterus has been satisfactory in all cases and there has been no postpartum hæmorrhage.

An added attraction of the method is the prolonged period of post-operative freedom from pain and restlessness. It varies from patient to patient but in one was allayed for 24 hours and she required only one dose of Heroin gr. 1/10 and that 26 hours after operation.

The post-operative pulse and blood-pressure have remained singularly steady. In one case of A.P.H. who started with a low blood-pressure it did fall, but she responded readily to simple rest in bed. It has been a pleasure to see the patient leave the theatre smiling, in good condition and return to the ward able to enjoy its activities.

There has been no incidence of headache, except a mild type in one patient with toxæmia who had headaches pre-operatively; chest complications have been absent, possibly because there is no intercostal paralysis by this method; no urinary difficulties have arisen nor have there been any instances of paralytic ileus. Vomiting has been almost negligible. The possibilities of meningitis, residual paralyses, damage to the cord and syncope are minimized by the very nature of the epidural space, which ends at the foramen magnum and is outside the subarachnoid space, and by the rigid adherence to all technical precautions, especially the negative pressure sign. The site of the single injection is in an area where sepsis is not likely to be superimposed during the puerperium.

Certain contra-indications to its use must be mentioned. Sepsis at the site of injection. The absence of a negative pressure. An unco-operative patient.

The following are the case reports and anæsthetic charts of four patients selected from our series.

CASE 1. A multigravida aged 37 years.

Indications for Cæsarean section: (*a*) her only baby was

stillborn; (*b*) A right occipito posterior with high head presenting; (*c*) primary uterine inertia.

Clinical data: The antenatal blood-pressure averaged 110/70 and was 106/72 immediately prior to the epidural injection.

Premedication: 100 mg. Pethedine intramuscularly 1½ hours before operation; 100 mg. Pethedine ½ hour before operation intramuscularly.

Anæsthetic: 45 c.cm. of 1/600 Nupercaine were injected between lumbar 2 and 3 into the epidural space. The blood-pressure fell to 95/65 twenty minutes later and ephedrine was given ½ gr. intravenously and ½ gr. intramuscularly. The skin was completely insensitive in 25 minutes. No supplementary anæsthesia was used, the patient being asleep during most of the operation.

Operation: Lower segment Caesarean section was performed, relaxation was good and there was a minimum of bleeding.

Infant: The foetal heart was 140 per minute and regular before the anæsthetic was commenced and was unaltered by the epidural injection. The baby was a male weighing 7 lb. 11 oz. and cried on delivery.

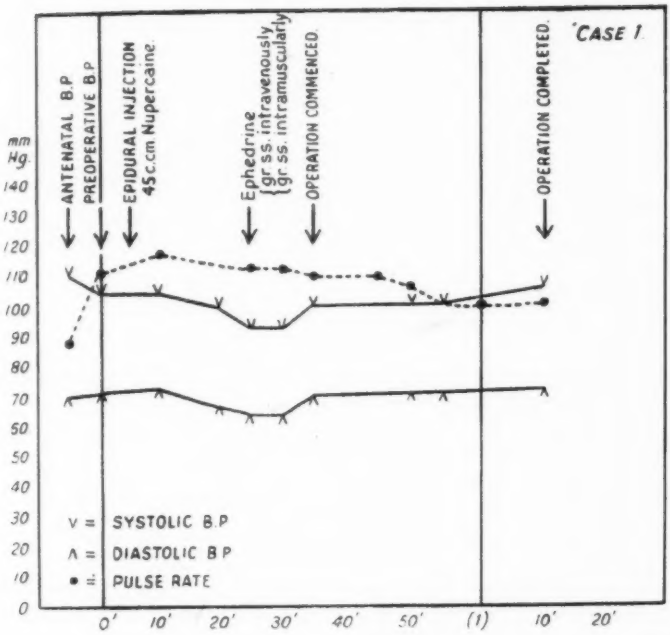
Post-operative condition and progress: At the end of operation the blood-pressure was 108/72 and this remained steady during the first day. The patient was awake and free from pain and her condition most satisfactory. Not until 24 hours later did she complain of moderate pain for which one injection of gr. 1/10 Heroin was adequate. She had no nausea or vomiting and no chest complications, etc.

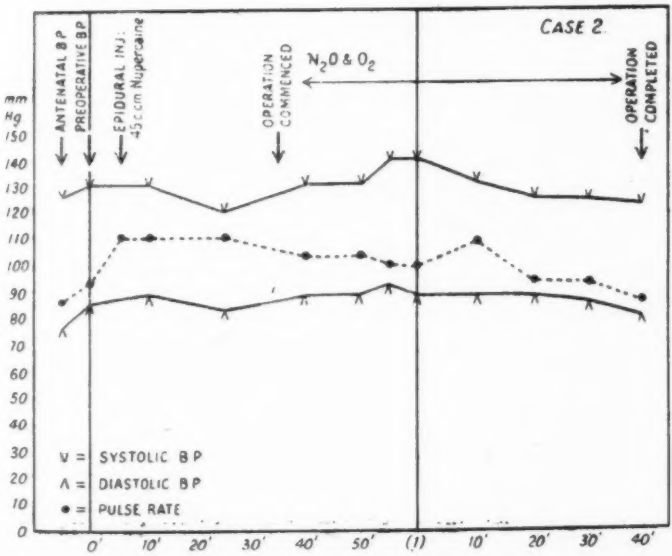
CASE 2. A primigravida aged 34 years.

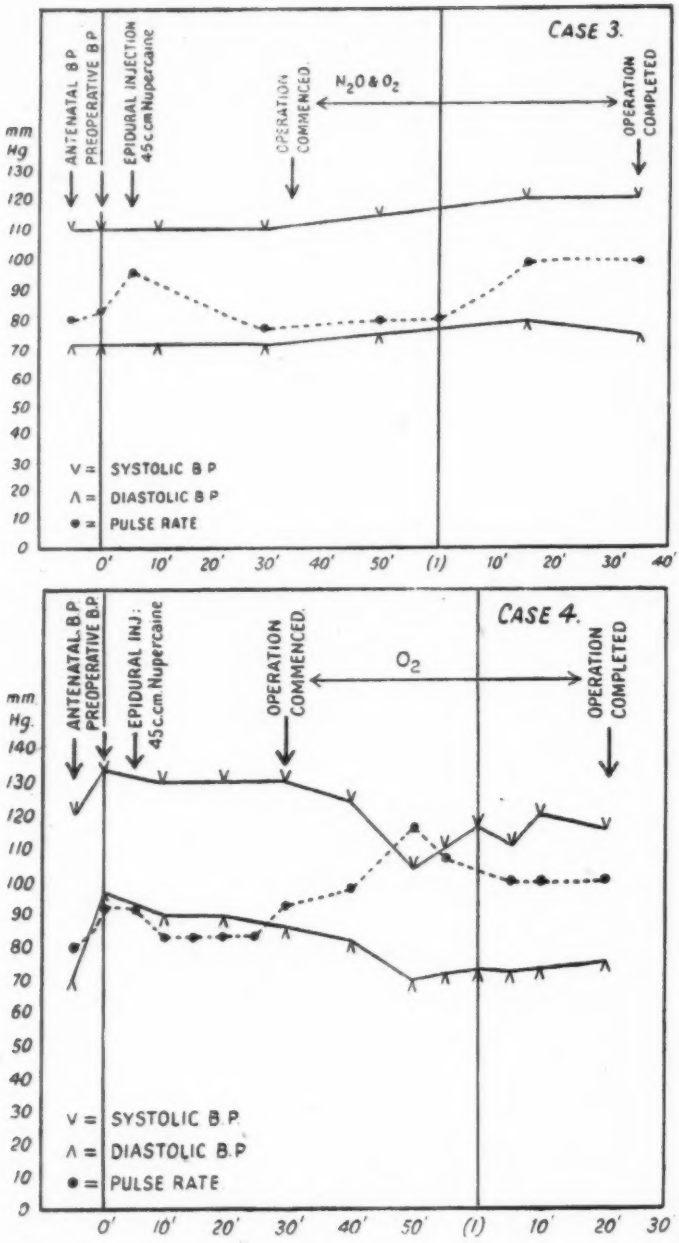
Indications for Cæsarean section: Multiple fibroids obstructing delivery, section being performed at 38 weeks, before the onset of labour.

Clinical data: The antenatal blood-pressure averaged 128/78 and was 130/85 immediately prior to the epidural injection.

Premedication: 100 mg. Pethedine 1½ hours before operation, repeated 1 hour later, and given intramuscularly. Also gr. 1/100 Atropine ½ hour before operation.


CASE 1
mm Hg.
ANTENATAL B.P
PREOPERATIVE B.P
EPIDURAL INJECTION 45c.cm Nupercaine
Ephedrine {gr.ss. intravenously {gr.ss. intramuscularly
OPERATION COMMENCED
OPERATION COMPLETED
V = SYSTOLIC B.P
Λ = DIASTOLIC B.P
• = PULSE RATE
0' 10' 20' 30' 40' 50' (1) 10' 20'


CASE 2
mm Hg
ANTENATAL B.P
PREOPERATIVE B.P
EPIDURAL INJ. 45c.cm Nupercaine
OPERATION COMMENCED
N_2O & O_2
OPERATION COMPLETED
V = SYSTOLIC B.P
Λ = DIASTOLIC B.P
• = PULSE RATE
0' 10' 20' 30' 40' 50' (1) 10' 20' 30' 40'


CASE 3.
ANTENATAL B P
PREOPERATIVE B P
EPIDURAL INJECTION 45 c.cm Nupercaine
OPERATION COMMENCED
N_2O & O_2
OPERATION COMPLETED
mm Hg
130
120
110
100
90
80
70
60
50
40
30
20
10
0
V = SYSTOLIC B P
Λ = DIASTOLIC B P
• = PULSE RATE
0'
10'
20'
30'
40'
50'
(1)
10'
20'
30'
40'
CASE 4.
ANTENATAL B.P
PREOPERATIVE B.P
EPIDURAL INJ.: 45 c.cm Nupercaine
OPERATION COMMENCED
O_2
OPERATION COMPLETED
mm Hg.
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
V = SYSTOLIC B.P
Λ = DIASTOLIC B.P
• = PULSE RATE
0'
10'
20'
30'
40'
50'
(1)
10'
20'
30

Anæsthetic: 45 c.cm. of 1/100 Nupercaine injected into the epidural space and the skin was insensitive in 25 minutes. No ephedrine was given because there was no appreciable fall in blood-pressure. Nitrous oxide and oxygen were given throughout this section as myomectomy had to be performed and it was considered kinder to render the patient unconscious for the more lengthy operation necessitated.

Operation: Lower segment Cæsarean section was performed and relaxation was good. Myomectomy was also performed.

Infant: The baby, a male weighing 9 lb. 2 oz., cried on delivery.

Post-operative condition and progress: At the end of operation the blood-pressure was 126/86 and the pulse 85 per minute. The patient was conscious almost immediately, smiling on waking and free from pain. Twelve hours later she complained of moderate pain, alleviated by Tabs: Codeine Co. and 19 hours after operation pain was more marked, necessitating one injection of Heroin gr. 1/10. There was no nausea or vomiting, no chest complications and no headache. The blood-pressure was steady for the next 12 hours.

CASE 3. A primigravida aged 29 years.

Indications for Cæsarean section: Antepartum haemorrhage due to central placenta praevia. The patient was 34 weeks pregnant.

Clinical data: General condition was quite good. The blood-pressure being 110/72 and the pulse 86 per minute.

Premedication: 100 mg.: Pethedine 1½ hours before operation repeated 1 hour later, given intramuscularly.

Anæsthetic: 45 c.cm. of 1/600 Nupercaine injected into the epidural space, the skin was insensitive in 20 minutes. No ephedrine was necessary. Nitrous oxide and oxygen were given throughout as the patient was rather apprehensive and asked to be put to sleep.

Operation: Lower segment Cæsarean section was performed.

Infant: The baby, a male weighing only 3 lb. 10 oz., cried on delivery and subsequently made very satisfactory progress.

Post-operative condition and progress: At the end of opera-

tion the blood-pressure was 120/74 and the pulse 100 per minute. The patient vomited about 1 oz. on recovering consciousness but had no subsequent nausea. She complained of abdominal pain 24 hours later and had gr. 1/10 Heroin hypodermically. The puerperium was uneventful.

CASE 4. A primigravida aged 33 years.

Indications for Cæsarean section: Antepartum haemorrhage due to placenta praevia.

Clinical Data: General condition was good. The blood-pressure was 138/98 and the pulse-rate was 90 per minute.

Premedication: 100 mg. Pethedine 1½ hours before operation and repeated 1 hour later, given intramuscularly.

Anæsthetic: 45 c.cm. of 1/600 Nupercaine injected into the epidural space, the skin was quite insensitive in 20 minutes. The patient had vomited considerably during her pregnancy and continued to retch during operation. In consequence oxygen was given and this relieved the condition.

Operation: Lower segment Cæsarean section was performed.

Infant: The baby, a female weighing 7 lb. 7 oz. cried on delivery.

Post-operative condition and progress: At the end of the operation the blood-pressure was 118/75 and the pulse was 100 per minute. General condition was most satisfactory and post-operative abdominal pain very mild and controlled by Tab Codeine Co. The puerperium was uneventful.

Finally, here is a short report volunteered by one of the ward sisters from the obstetric department at University College Hospital. She has nursed a great number of Cæsarean sections and her statement offers the patient's point of view. "The patients return to the ward conscious and are most co-operative. They are calm, and quiet, compared with the restlessness following general anæsthesia, and do not complain of thirst and are free from pain. As a rule their general condition is better than with other anæsthetics, and they do not vomit. Very soon after operation they are able to take light but solid food and hence are much less likely to get discomfort from flatulence. The amount of post-operative drugs required is much less than with general anæsthesia.

The impression of the nursing staff is in favour of epidural analgesia for Cæsarean sections."

So far none of our patients has complained, they like the anæsthetic and afterwards had only a hazy memory of the operation.

Our thanks are due to the surgeons of the Obstetrical Unit at U.C.H. for their patience, encouragement and co-operation and also to the ward sisters who have taken infinite care with the patients and given valuable assistance. We would also like to thank Dr. Massey Dawkins for the advice and tuition which he has so readily offered.

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PRELIMINARY INVESTIGATION OF THE USE OF CURARE IN ANÆSTHETIC PRACTICE AND FOR TREATMENT OF SPASTIC PARALYSIS

BY

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Consulting Anæsthetist, Withington Hospital, Manchester: Consulting Anæsthetist, E.M.S.

UNTIL recently the mention of curare conjured up visions of South American natives using their blow-pipes for killing cattle or waging warfare.

In 1940 Bennett in America reported "on the use of curare in treatment of various diseases such as Postencephalitis athetoid attacks and spasmodic torticollis," and stated that the injection of curare markedly diminished hypotonia and the tremors. Later Bennett and Bradley used curare in the treatment of spastic children in doses according to weight, both intravenously and intramuscularly.

Other uses of curare were in the diagnosis of Myasthenia Graves (when the symptoms become very over-exaggerated with small doses if the disease is present) and also to alleviate the convulsion of Metrazol or electrical shock therapy.

More recently, curare in the form of Introcostrin (the Squibb preparation of curare) has been used in anæsthetic practice, and excellent but transient relaxation has been obeained. However, it cannot be too strongly pointed out that curare is *not* an anæsthetic but that the action of this drug is the interruption of nerve impulses to muscle, the action taking place at the termination of the nerve fibres at the muscle cell. The probable reason for the action is the neutralization of the acetycholine factor which is essential for nerve and muscle stimulus. The action of curare is only on skeletal muscle and fortunately, the last muscles to be affected are the intercostals and the diaphragm. Thus, it is possible, with the correct dose, to obtain complete relaxation of all skeletal muscle and yet not interfere with respiration or cardiac rhythm.

I have been fortunate enough to obtain a limited supply of Introcostrin from Squibb and Sons of New York, who supply this in vials each containing 20 mg. of purified curare to 1 c.cm. of the fluid. With this limited supply I have set out to make a preliminary investigation of curare in respect of its use for anæsthetic purposes, for conditions of the nervous system where there is spasticity and for involuntary movements.

In correspondence from Canada and America I find that curare, when used for anæsthetic purposes is employed not so much to produce relaxation with light gas anæsthetic, but more as an adjuvant to a general anæsthetic in which sufficient relaxation has not been obtained, e.g. an upper abdomen in a strong man.

In the cases in which I have used curare to obtain relaxation I have relied entirely on this drug for the relaxation and have only employed gas and oxygen to render the patient analgesic with no volatile anæsthetic as an adjuvant. In each of these cases I have adopted the following technique. Morphia is given pre-operatively but no atropine is used (except in one case) as it is stated that this should not be administered, although, in the one case in which it was given, no ill effects followed. Prostigmine (1 to 2 c.cm. intravenously) is advised as an antidote if there should be signs of overdosage, respiratory difficulty or excessive and prolonged muscular relaxation. I have found in my investigations so far, that there has not been any necessity for the use of prostigmine or artificial respiration, although several of the patients have not been in first-class condition before being anæsthetized. I attribute the lack of complication at present to slow injection and a careful observation of the pulse and respiration. A point to be remembered in all cases in which intubation is not employed is that, in the event of vomiting, there is a risk of inhalation of the vomit as there is temporarily no swallowing reflex and the cords of the larynx are paralyzed.

Cases in which Curare has been Employed for Anæsthesia

1. *Haemorrhoids*—Relaxation after 5 c.cm. except for stiff elbows—complete relaxation after 8 c.cm. Sphincter relaxed

but more bleeding than with spinal anæsthetic. Blood-pressure normal throughout operation. Recovery after twenty minutes complete. Gas and oxygen given prior to and during operation.

2. *Proctoscopy.*—Perfect relaxation for examination and abdominal relaxation for bimanual examination excellent. Diaphragm movement not impaired, no cyanosis or respiratory depression. Blood-pressure 130 after administration of curare. Gas and oxygen employed.

3. *Proctoscopy*—Elderly and rather fragile patient. Blood-pressure raised 20 per cent. Perfect relaxation coming on after two minutes. No respiratory depression.

4. *Removal of stump of humerus and resuturing*—Curare administered together with gas and oxygen. Relaxation perfect. Patient rather excited after the operation, crying and shouting. Probably a psychological state as no premedication given.

5. *Removal of foreign body in foot*—Patient a muscular soldier. Relaxation + for period of 15 minutes in conjunction with gas and oxygen.

6. *Foot manipulation and re-plaster*—Blood-pressure as at commencement of operation.

7. *Manipulation*—Healthy man. Severe headache and vomiting after recovery. Probable cause of headache and vomiting due to fact that doctor administering gas and oxygen had kept patient in very anoxic state for several minutes.

8. *Manipulation of both feet and knee for adhesions*—Patient old lady. Perfect relaxation, no respiratory or cardiac embarrassment.

9. *Manipulation of knee*—Very muscular man who had previously taken very large doses of ether for operation on his knee—with curare perfect relaxation for 15 minutes for manipulation—feeling of well-being following, no vomiting or fall of blood-pressure.

10. *Manipulation of foot*—healthy man. Curare and gas and oxygen produced as good relaxation as with deep anæsthesia.

Cases of Paralysis Treated With Curare

1. A fairly advanced case of disseminated sclerosis with badly affected left leg. (*a*) After 1 c.cm. intramuscularly—no effect. (*b*) After 2 c.cm. intramuscularly—felt a little better. (*c*) After 1 c.cm intravenously—eyes became crossed and whole body a little limp for 30 minutes, but better in evening and able to walk out. Improved for 3 days then I.S.Q. (*d*) After 2 c.cm. intravenously—patient very dizzy for 15 minutes but able to walk "nearly as well as yourself" in the evening following injection. This improvement lasted only for the evening, but patient stated she was better for 3 days to a certain degree. (*e*) After 3 c.cm. intravenously—as above.

A Parkinsonian with marked mask-like face and tremors of the left side of her face when not taking a Hyoscine medicine t.d.s. The medicine controls the spasm and, to a certain degree, the shaking of the limbs. (*a*) After 1 c.cm. intravenously the twitching of her face was controlled for 3 days and she felt "mentally better." This mental change has been noted in an article by Denhoff and Bradley in which the spastic children are described as feeling "light and happy." The muscular rigidity did not however diminish appreciably. (*b*) The same dosage as above with the addition of half doses of hyoscine medicine. This seemed more satisfactory. (*c*) After 3 c.cm. given intravenously, with no medicine, the same feeling of well-being was produced with cessation of the trembling and no medicine was required for two days. (*d*) 3 c.cm. dose repeated with same results.

3. A fairly advanced disseminated sclerosis combined with Parkinsonian facies and right-handed tremor. This was an interesting case as the effect on spasticity and tremor could be seen in the same case. (*a*) After 2 c.cm. intravenously patient said that the pointing of her right foot disappeared 8 hours after the injection and was free for nearly 2 days. The tremor, if anything, was rather worse. (*b*) After 3 c.cm. intravenously the same effect on the foot occurred and she was able to knit for two hours in the evening after the injection, which she had not done for two years. (*c*) After 2 c.cm. intravenously results about equivalent of the above were observed and a well-marked feeling of well-being, which the patient volunteered

herself. (*d*) Same dosage with the usual feeling of dizziness, diplopia and weakness for 15 minutes. Patient then felt exceptionally well and did a long shopping expedition which she had not done for a long time. States she walked perfectly well for 8 hours. (*e*) As above. Patient looks forward to the injection now as it makes her walk so much better.

4. A case has been diagnosed by a neurologist as a degenerative and idiopathic Parkinsonian disease affecting the right hand and forearm. The condition is that of some degree of spasticity and an early tremor. (*a*) After 1 c.cm. intramuscularly—no effect. (*b*) After 2 c.cm. intramuscularly—may have reduced spasticity a little. (*c*) After 2 c.cm. intravenously—reduced spasticity considerably but tremor not affected. Patient had usual double vision and eyelid drop for 15 minutes. (*d*) Dose as above. It would appear that the spasticity in these cases is much more controllable than the tremor. However, small doses of hyoscine, by mouth, can be taken if necessary to control the latter. (*e*) After 3 c.cm. intramuscularly—prolonged effect of 4 to 5 days, but not so dramatic. Effect more prolonged than after an intravenous injection.

Conclusion

After my short improved experience of curare I am sure that with more experience and technique in order to prolong the effects of the drug in spastic cases there is a very important advance in therapeutics. Also, as a new drug in the armamentaria of anæsthesia, Curare, when correctly used, will be of great assistance to obtain that perfect relaxation, at present usually limited to spinal anæsthesia. As the drug stands, at the moment, in anæsthesia, it appears to me that the main use is for manipulation and examinations which require a short but perfect relaxation, such as a pelvic or bimanual examination.

It is hoped that the present cost of this drug may shortly be brought within the range of popular usage.

The blow-pipe death drug may well come to be one of the greatest benefits to spastic paralytics and to the art of anæsthesia.

ABSTRACTS

"*Continuous Spinal Anæsthesia.*" MARTIN, LIVINGSTONE and WELLMAN, *Archives of Surgery*, March 1945, p. 130.

The article is based on the experience of 1,200 operations. Procaine hydrochloride in 5 per cent solution was the anæsthetic employed. A special mattress with portion cut out corresponding to the lumbar region of the spine is required. Pentobarbitol and morphine was given one and a half hours before operation. The mattress is constructed in sections for use when the patient is in various positions. Extra-long metal holders for shoulder braces were needed because of the thicknesses of the mattress.

A Sise introducer was used to puncture the skin and make a point of entrance for the malleable german-silver spinal needle. These were in three sizes 17, 18 and 19 gauge and $3\frac{1}{2}$ to 4 inches long. When the puncture has been successfully made a 10 c.cm. Luer-hok syringe is fitted to the hub of the needle. Four c.cm. of spinal fluid were withdrawn and mixed with an equal quantity of 10 per cent Procaine hydrochloride solution. The injection being made while the patient lies on his side two assistants then turn him into the supine position, the anæsthetist holding the syringe and tubing so that the needle is not displaced and the tubing lies free in the space provided in the mattress. The table was kept flat for five minutes after injection. If then the level of anæsthesia was not high enough the table was placed in various degrees of the Trendelenburg position until the desired level was reached. If at the end of ten minutes the anæsthesia was not high enough an additional 1 c.cm. of the Procaine-spinal fluid was rapidly injected. The average patient needed additional injections of 50 mg. at the end of the first hour and every half hour after. After operation the patient was kept flat with no pillow for twenty-four hours. In 72 per cent of the patients anæsthesia lasted one and a half to three hours. The longest

operation (a total pancreatectomy) took seven hours and three-quarters. Nausea and vomiting were the complications most frequently met during anæsthesia in 17 per cent of the patients. Complete intercostal paralysis due to high block occurred in one patient. Recovery is complete after oxygen inhalation and ephedrine. Twenty-five patients (4.4 per cent) had post-operative pulmonary complications. Urinary retention was 4 per cent and cystitis 2 per cent. Retention rarely lasted more than two or three days. There were no fatalities in the operating theatre. Mortality was 8 per cent, thirty-three of the deaths were patients with malignant disease.

GLASGOW AND WEST OF SCOTLAND SOCIETY OF ANÆSTHETISTS

At a meeting in the Western Infirmary, Glasgow, on Tuesday, 15th January, 1946, anæsthetists in Glasgow and the West of Scotland decided to form a Society of Anæsthetists and to adopt the name stated above. Representatives were present from the Royal, Western and Victoria Infirmaries and from the Corporation of Glasgow Hospitals. In addition there was a welcome representation from such towns as Paisley, Ayr and Falkirk. Membership is open to anæsthetists holding appointments in Glasgow and the West of Scotland, and to resident anæsthetists and trainees during the period of their appointments. It is proposed to hold four, or at the most five, meetings during the winter months, with the following objects :

1. To promote the development of this special branch of medicine in the area specified.
2. To encourage friendship among anæsthetists in the West of Scotland.
3. To offer opportunities for the discussion of anæsthetic methods and problems.
4. To co-ordinate anæsthetic activities and teaching, and if and when necessary, to represent anæsthetists, and attempt to protect their interests.

Officials to hold office until April 1947 were elected as follows : President, D. Keir Fisher ; Secretary and Treasurer, H. H. Pinkerton ; Editorial Secretary, I. M. Campbell Dewar ; Committee : A. C. Forrester, Andrew Tindal, Albert Christie and K. C. Grigor.

REVIEWS

"*Intravenous Anæsthesia.*" R. CHARLES ADAMS, M.D., C.M., M.S., pp. 663 and xiv. 75 illustrations. Paul B. Hoeber, New York 1944. $12.00.

All professional anæsthetists owe a deep debt of gratitude to Dr. Adams for collecting in one volume an exhaustive account of everything that pertains to this specialized technique of anæsthesia. Intravenous anæsthesia came into its own abruptly in the autumn of 1932 with the introduction of the barbiturate "Evipan" in Germany. It has since spread far and wide, a further impetus having been given to its vogue by the thiobarbiturate "Pentothal" whose use was popularized by the Clinic of whose staff the author is a member.

The book is literally exhaustive. Apart from the obvious chapters devoted to history and technique, every agent which has ever been used for this purpose is discussed in a separate chapter. Local analgesia by venous and arterial routes, analeptics, and the place of the method in war are similarly treated. The author uses the term "Avertin" as synonymous with tri-brom-ethyl alcohol, whereas the former is a trade name for the saturated solution of the latter in amylene hydrate. One would have thought that such a solution, even when diluted to three per cent, was less suitable for intravenous administration than a solution of the crystals in water or saline. The author's description of the administration is quoted from Kirschner and others and is not explicit as to such details.

The references reach the astounding total of 3,489. This is a trifle confusing to the reader, who has no means of distinguishing between the vital and the unimportant ones. In a further edition we hope that the author will share his expert knowledge with the reader by differentiating for him between the important and the unimportant; as well as by his existing classification of "relevant articles not referred to in the text."

Intravenous anæsthesia has come to stay: if only for the excellent reason that, to the patient, it is the least unpleasant known form of induction into anæsthesia. Large numbers of them now ask for it, and should not be denied this solace without good reason. Because of this the information contained in this book should be available to every medical man who administers anæsthetics. Few of these, however, who are not experts or teachers will feel justified in paying so high a price for so large a volume, for this savours of extravagance. It is, therefore, very much to be hoped that the author will prepare a shortened digest of the essential facts, documented by references only to the articles which are vital to the subject, which could be sold at a lower price to a much wider public.

The British reader, although he will often wince at the omission of diphthongs and other "modernizations" which are unfortunately in vogue in America, will keenly appreciate the high standard of clarity of writing with which the subject is presented. The book is well-produced, attractively bound, and profusely illustrated. Its author is to be warmly congratulated on giving us so complete, valuable, and well-written a work.

"*Anæsthesia in Operation for Goitre.*" STANLEY ROWBOTHAM, M.D., D.A., Hon. Anæsthetist to Royal Free, Charing Cross, and Royal Cancer Hospitals. Blackwell Scientific Publications, Oxford, pp. 104. Price 12/6.

The special risks incident to goitre operations and the special skill and experience required for their satisfactory anæsthesia fully warrant a monograph of this description by Dr. Rowbotham, who has had so extensive an experience in this particular department of anæsthetic work.

He starts with an account of the anatomy and the diseases of the gland, without a knowledge of which anæsthetists would be unlikely to make a success of administrations for goitre operations. And, as he states, all thyroid patients, if not frankly myxœdematous, are potentially thyrotoxic and must be so regarded when they come to operation.

The patients are divided into good, fair, and poor risks.

The last include those with poor or absent iodine response, rising basal metabolic rate, and the presence of complications, e.g., cardiac failure and hyperpoiesis. Resistance to anæsthesia is proportional to the basal metabolic rate; so also are reflex excitability and power to eliminate narcotics. As preoperative preparation Rowbotham recommends Lugol's iodine ♏10 three times a day in milk or water, and Elixir Valerian C. For urgent operations he uses pentothal and then cyclopropane after intubation. Morphine gr. $\frac{1}{32}$ per stone of body weight or chloral gr. ? per stone are given four hours before operation and for every increase of 10 per cent B.M.R. an increase is added of 0.2 gr. per stone.

Before local infiltration

Omnopon gr. $\frac{1}{30}$ }
Hyostone gr. $\frac{1}{1000}$ } per stone are given,

the local analgesic recommended is

Amethocaine hydrochloride 1–4,000 }
Adrenaline 1–400,000 } in normal saline,

the maximum dose being 150 c.cm.

Cocainisation of the goitre is recommended before intubation.

CORRESPONDENCE

The Editor, *British Journal of Anæsthesia*.

Sir—A catalogue of all the medical films in Great Britain is now being prepared by the Royal Society of Medicine in co-operation with the Scientific Film Association. It would be appreciated if any persons holding films of medical or paramedical interest, who have not already been asked for details, would communicate with the Film Cataloguer, Royal Society of Medicine, 1 Wimpole Street, W.1. By so doing they would not commit themselves or their films, but would enable the catalogue to be complete.

Yours faithfully,

GORDON GORDON-TAYLOR
Surgeon Rear-Admiral;
President,
Royal Society of Medicine.

ARTHUR ELTON
President,
Scientific Film Association.